BIOASSAYS OF ADCOM WIRE PRODUCTS
COOLING WATER DISCHARGE OUTFALL #003
TEST #2
JACKSONVILLE, DUVAL COUNTY, FLORIDA
NPDES #FL0030121

SAMPLED MAY 12, 1982

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Biological Section
Bureau of Water Analysis
July 12, 1982

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# EXECUTIVE SUMMARY

Adcom Wire Products, Cooling Water Discharge, Outfall #003, NPDES #FL0030121, on 11 to 13 May, 1982

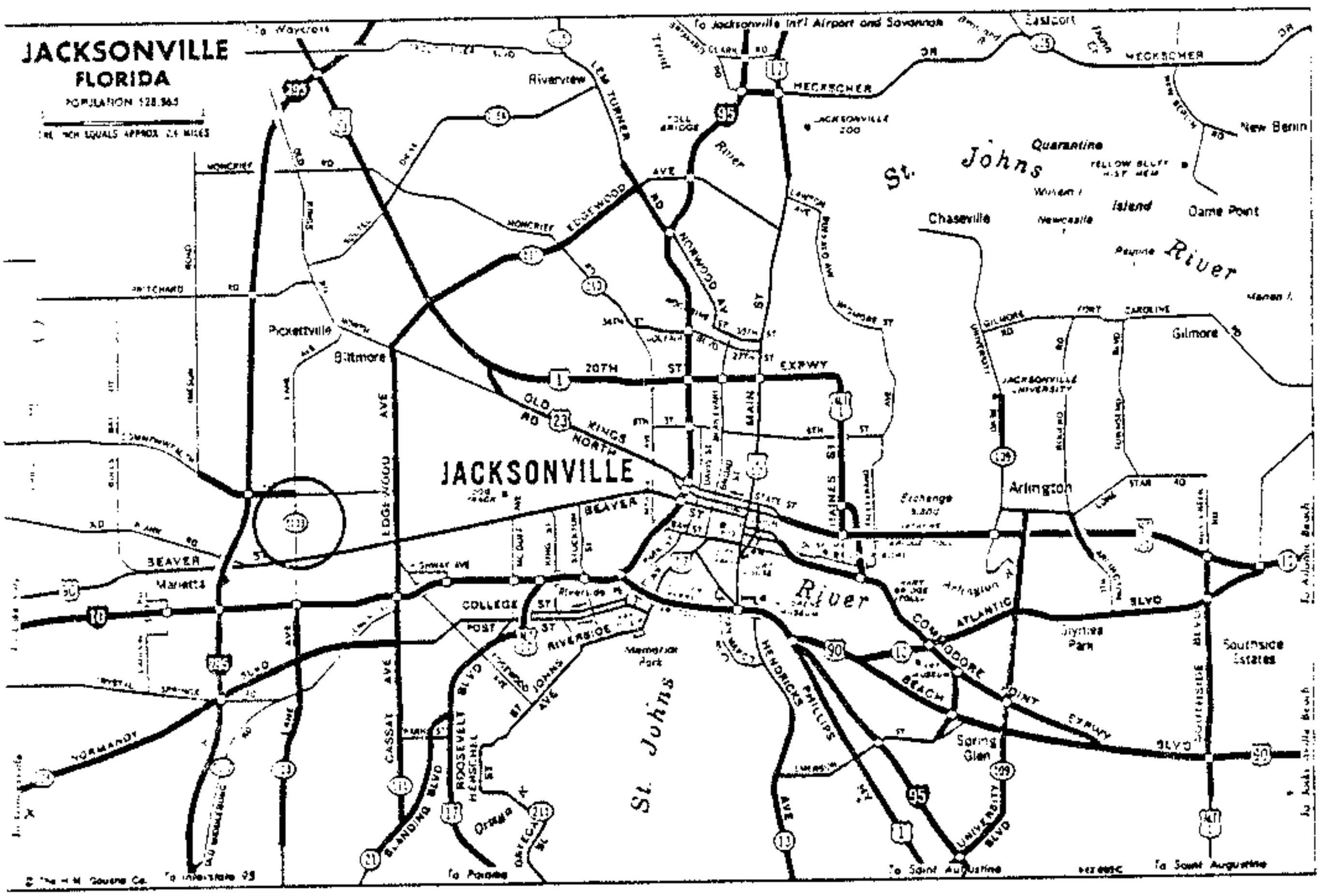
The sample of contact cooling water effluent from this discharger, a steel wire recycling facility located in Jacksonville, was acutely toxic to Daphnia pulex and Simocephalus serrulatus, but was not toxic to Heterandria formosa. The 48 hour $LC_{50}$ values of 100% to 156% were determined for the Daphnia pulex bioassay. A 48 hour $LC_{50}$ of 226% was determined for the Simocephalus serrulatus bioassay. No Heterandria died during the 48 hour static test. The cause of the toxicity in this cooling water effluent may be due to the synergistic effects of several heavy metals found in the effluent, including 450 µg/l of zinc.

# INTRODUCTION

Adcom Wire Products, also known as Container Wire Products, operates from a facility located at 925 N. Lane Ave., Jacksonville, Duval County, Florida (Fig. 1). It produces a finished steel wire from the pickling, drawing and galvanizing of old steel wire. Wastewater from this operation consists of concentrated sulfuric acid, pickling acid, process rinse water and boiler blowdown. The wastewater is treated with lime to neutralize the acid and to precipitate iron, the major component. According to district personnel, this discharge of process wastewater has been discontinued. However, another discharge from this facility consists solely of contact cooling water, which is used to cool the hot steel wire after processing. This discharge enters an adjacent ditch which flows to the Cedar River, and ultimately, the St. Johns River.

In October 1981, the Biological Section performed static acute toxicity bioassays on a sample of Adcom Wire Products contact cooling water discharge. Results of those tests indicated acute toxicity to the test organism, Daphnia pulex, with a 48 hour $LC_{50}$ of 86.8% (FDER 1981). The bioassay using Simocephalus serrulatus was invalidated at 48 hours due to excessive control mortality. The exact degree of toxicity at that time was in doubt, due to some Daphnia control mortality and to the large 95% confidence intervals produced by the irregular distribution of mortality. Additionally, a cause for the observed toxicity could not be attributed at that time, since no chemical analyses were performed. Therefore, the Biological Section recommended that bioassays be repeated on this particular effluent.

To further evaluate the existence and extent of toxicity of this contact cooling water effluent to the biota of the receiving waters, the Biological Section performed additional static acute toxicity bioassays on a grab sample, on 11 to 13 May, 1982. The results of these latest tests are presented in this report.



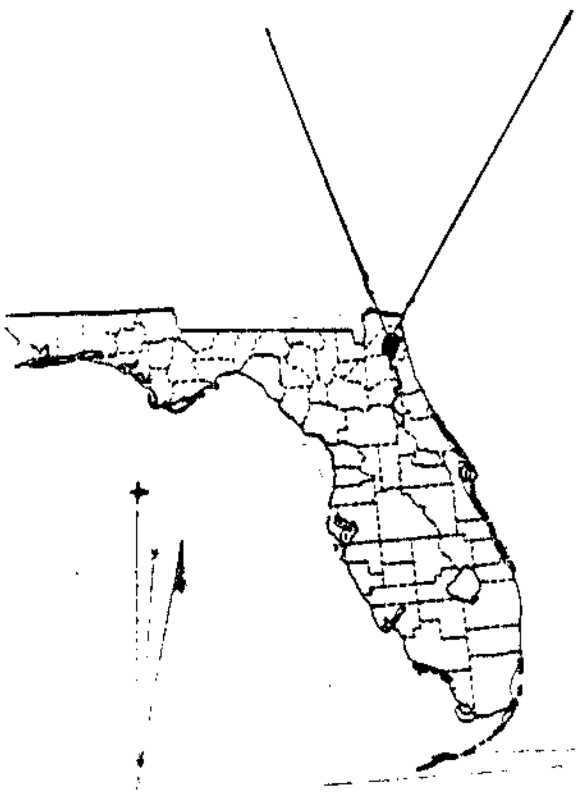



Figure 1. The City of Jacksonville, Duval County, Florida, including approximate location of Adcom Wire Products.

## METHODS AND MATERIALS

Test methods used to conduct these static bioassays are extensively described by Peltier (1978). The organisms selected for this study include a species recommended by Peltier (1978) and the U.S. EPA (1978). Additionally, the Biological Section maintains cultures of several species of organisms indigenous to the State of Florida. Two of these indigenous species were also selected for testing. Life histories of these test organisms and maintenance procedures used to culture them are detailed below.

### History and Maintenance of Bioassay Organisms

Daphnia pulex (water flea) - A breeding culture of Daphnia pulex was obtained from the EPA laboratory in Athens, Georgia, in March, 1979. This culture has been maintained since its arrival in 2 1/2 gallon all glass aquaria filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. Organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of 22° plus or minus 1°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Simocephalus serrulatus (water flea) - An indigenous breeding population of Simocephalus serrulatus was collected from Lake Jackson, Leon County, Florida, in March, 1980, by personnel from DER's Biological Section. Positive identification of the organisms was made by Mr. Jeff Foran of the University of Florida Department of Environmental Engineering Sciences. The cultures are maintained in two and one-half gallon all glass aquaria, filled with unchlorinated DER well water, under a 16:8 hour light-dark cycle. The organisms are fed a liquified blend of Purina Trout Chow® and Cerophyl® twice daily, and are kept at a constant temperature of 22° plus or minus 1°C. The aquaria are cleaned weekly by siphoning off half the water along with the detritus and excess organisms. They are then refilled with fresh aerated well water. Additional measures are taken and/or new cultures started in the event of abnormal circumstances such as: declining populations, ephippia formation, or excessive fungal or bacterial growth.

Heterandria formosa (least killifish) - Approximately 100 adult least killifish were obtained from a wild population in the St. Marks Wildlife Refuge (Wakulla County, Florida) during August, 1980. The fish are maintained in two and one-half to 15 gallon all glass aquaria equipped with a flow through water exchange system. Water for this system is unchlorinated and is pumped from a deep well near the DER laboratory. The least killfish are reared at 22° plus or minus 2°C under a 16:8 hour light-dark cycle and are fed freshly hatched Artemia (brine shrimp) twice daily. New born fish are initially maintained in the adult tanks, but are removed at weekly intervals, thereby segregating fish into even age groups. The fish used in this test were 7 to 14 days old.

To ensure the uniform sensitivity of these test organisms to toxic substances, the Biological Section conducts monthly standard reference toxicant bioassays using sodium lauryl sulfate as the reference toxicant.

## Test Methods

Three separate 48 hour static acute toxicity bioassays were performed on a grab sample of Adcom's contact cooling water discharge from Outfall #003. The tests were performed from 1115 hours on 11 May to 1130 hours on 13 May, 1982.

The sample was collected by Ms. Teresa Ashworth of DER's Jacksonville Office at 1330 hours on 10 May, 1982, using standard wastewater sampling procedures. Separate samples were obtained for chemical and biological testing. Samples for metal analysis were preserved with $HNO_3$. Samples for the bioassays were unpreserved. The samples were iced and transported to the DER laboratory in Tallahassee for analysis within 24 hours of collection.

Freshwater for dilution of the effluent sample was obtained from the same DER deep well that is used to culture the test organisms. The concentration series selected for this study (Table 1) is that recommended by APHA (1980).

Two replicates, each with six concentrations and a control, were used to test with the water fleas, Daphnia pulex and Simocephalus serrulatus. Flint glass jars of 250 ml capacity were used as test chambers, and 200 ml of the appropriate test concentration was placed in each chamber. Daphnia and Simocephalus were siphoned into large culture dishes to isolate the proper size and age organisms (neonates). To accomplish this, the Daphnia were siphoned through a stainless steel screen. The trapped adults were then discarded. Simocephalus neonates were separated from the adults visually in the culture dish prior to loading. These neonates were then transferred by glass pipette, examined for injury, and were loaded 10 per chamber, resulting in 20 per test concentration. Water fleas were not fed during these tests.

Two replicates, of five concentrations and a control, were used for the Heterandria formosa (least killifish) bioassay. The fish were transferred individually or by twos, by net, into wide mouth quart jars containing 500 ml each of the appropriate test concentration, and were loaded 5 per chamber, resulting in 10 per concentration. Fish were not fed during this test.

Dissolved oxygen, pH, temperature, and the number of live organisms were recorded for each test chamber at 0 hours, 24 hours, and 48 hours. Total alkalinity and total hardness were recorded at the beginning of the test for the controls and the 100% effluent concentration. The specific conductance of each test concentration was recorded at the beginning and end of the test. Ammonia concentrations, including total and unionized fractions (expressed in mg/l as N and as $NH_3$, respectively), were recorded in the controls and the 100% effluent test concentration at the beginning of the test. Total ammonia concentrations were determined using an Orion® specific ion probe and an Orion Ionalyzer®. The unionized fraction was then determined based on the total ammonia concentration, and the pH, temperature, and salinity of the sample. These values were recorded on the bioassay data forms and are presented in Tables 2 through 4.

Table 1. Concentration Series and Volumes Used for These Static Bioassays

*Daphnia pulex* and *Simocephalus serrulatus* (water fleas)

| Concentration | Dilution Water | Effluent | Total Volume |
|---|---|---|---|
| Control | 200 ml | --- | 200 ml |
| 5.6% | 188.8 ml | 11.2 ml | 200 ml |
| 10.0% | 180 ml | 20 ml | 200 ml |
| 18.0% | 164 ml | 36 ml | 200 ml |
| 32.0% | 136 ml | 64 ml | 200 ml |
| 56.0% | 88 ml | 112 ml | 200 ml |
| 100.0% | -- | 200 ml | 200 ml |

*Heterandria formosa* (least killifish)

| Concentration | Dilution Water | Effluent | Total Volume |
|---|---|---|---|
| Control | 500 ml | --- | 500 ml |
| 10.0% | 450 ml | 50 ml | 500 ml |
| 18.0% | 410 ml | 90 ml | 500 ml |
| 32.0% | 340 ml | 160 ml | 500 ml |
| 56.0% | 220 ml | 280 ml | 500 ml |
| 100.0% | --- | 500 ml | 500 ml |

Table 2. Data recorded during 48 hour, *Daphnia pulex*, static acute toxicity bioassay of Adcom Wire Products Cooling Water Discharge, Outfall #003, NPDES #FL0030121, Jacksonville, Florida, on 11 to 13 May, 1982.

| Conc. or % | Number of Live Organisms | | | Dissolved Oxygen (mg/ℓ) | | | pH | | | Total Alkalinity (mg/ℓ as $CaCO_3$) | | Total Hardness (mg/ℓ as $CaCO_3$) | | Temperature (°C) | | | $NH_3/NH_3+NH_4$ (mg/ℓ) | | Conductivity (µmhos) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 |
| Control | 10 | 10 | 10 | 8.2 | 9.1 | 8.7 | 7.9 | 8.3 | 8.3 | 118 | | 110 | | 20.3 | 19.5 | 20.4 | 0/0 | -- | 210 | 210 |
| Control | 10 | 10 | 10 | 8.2 | 9.1 | 8.7 | 7.9 | 8.3 | 8.3 | | | | | | | | | | | |
| 5.6% | 10 | 9 | 9 | 8.1 | 9.1 | 8.7 | 7.9 | 8.3 | 8.3 | | | | | 20.2 | 19.5 | 20.1 | | | 225 | 220 |
| 5.6% | 10 | 10 | 9 | 8.2 | 9.1 | 8.7 | 7.9 | 8.3 | 8.3 | | | | | | | | | | | |
| 10.0% | 10 | 10 | 9 | 8.2 | 9.1 | 8.7 | 7.9 | 8.3 | 8.3 | | | | | 20.2 | 19.5 | 20.1 | | | 235 | 235 |
| 10.0% | 10 | 9 | 9 | 8.2 | 9.1 | 8.6 | 7.9 | 8.3 | 8.3 | | | | | | | | | | | |
| 18.0% | 10 | 9 | 6 | 8.2 | 9.1 | 8.6 | 7.9 | 8.3 | 8.3 | | | | | 20.3 | 19.5 | 20.1 | | | 255 | 250 |
| 18.0% | 10 | 10 | 7 | 8.2 | 9.1 | 8.6 | 7.9 | 8.3 | 8.3 | | | | | | | | | | | |
| 32.0% | 10 | 10 | 7 | 8.2 | 9.1 | 8.5 | 8.0 | 8.3 | 8.3 | | | | | 20.2 | 19.5 | 20.2 | | | 290 | 285 |
| 32.0% | 10 | 10 | 7 | 8.2 | 9.1 | 8.5 | 8.0 | 8.3 | 8.3 | | | | | | | | | | | |
| 56.0% | 10 | 9 | 6 | 8.1 | 9.0 | 8.5 | 8.0 | 8.3 | 8.3 | | | | | 20.2 | 19.5 | 20.2 | | | 345 | 340 |
| 56.0% | 10 | 10 | 10 | 8.0 | 9.0 | 8.5 | 8.0 | 8.3 | 8.3 | | | | | | | | | | | |
| 100.0% | 10 | 10 | 4 | 7.5 | 9.0 | 8.5 | 8.1 | 8.3 | 8.3 | 122 | | 221 | | 20.2 | 19:6 | 20:4 | 0/0 | -- | 440 | 440 |
| 100.0% | 10 | 10 | 6 | 7.5 | 9.0 | 8.5 | 8.2 | 8.3 | 8.3 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

Remarks: Total Chlorine Residual: 0 mg/l (HACH DPD Method).

Table 3. Data recorded during 48 hour, Simocephalus serrulatus, static acute toxicity bioassay of Adcom Wire Products Cooling Water Discharge, Outfall #003, NPDES #FL0030121, Jacksonville, Florida, on 11 to 13 May, 1982.

| Conc. or % | Number of Live Organisms | | | Dissolved Oxygen (mg/ℓ) | | | pH | | | Total Alkalinity (mg/ℓ as $CaCO_3$) | | Total Hardness (mg/ℓ as $CaCO_3$) | | Temperature (°C) | | | $NH_3/NH_3+NH_4$ (mg/ℓ) | | Conductivity (µmhos) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 |
| Control | 10 | 10 | 10 | 8.0 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | 118 | | 110 | | 20.2 | 19.4 | 20.1 | 0/0 | --- | | |
| Control | 10 | 10 | 8(9)[a] | 8.0 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | | | | | | 210 | 220 |
| 5.6% | 10 | 10 | 10 | 8.1 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | 20.2 | 19.4 | 20.0 | | | | |
| 5.6% | 10 | 10 | 10 | 8.1 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | | | | | | 230 | 230 |
| 10.0% | 10 | 10 | 10 | 8.1 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | 20.3 | 19.4 | 20.0 | | | | |
| 10.0% | 10 | 10 | 10 | 8.1 | 9.1 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | | | | | | 240 | 245 |
| 18.0% | 10 | 9[b] | 9 | 8.1 | 9.0 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | 20.3 | 19.4 | 20.0 | | | | |
| 18.0% | 10 | 10 | 8 | 8.1 | 9.0 | 8.5 | 7.9 | 8.3 | 8.3 | | | | | | | | | | 260 | 260 |
| 32.0% | 10 | 10 | 10 | 8.1 | 9.0 | 8.4 | 8.0 | 8.3 | 8.3 | | | | | 20.2 | 19.4 | 20.1 | | | | |
| 32.0% | 10 | 10 | 8 | 8.1 | 9.0 | 8.4 | 8.0 | 8.3 | 8.3 | | | | | | | | | | 290 | 300 |
| 56.0% | 10 | 10 | 9 | 8.0 | 9.0 | 8.4 | 8.0 | 8.3 | 8.3 | | | | | 20.0 | 19.4 | 20.0 | | | | |
| 56.0% | 10 | 10 | 9 | 8.0 | 9.0 | 8.4 | 8.0 | 8.3 | 8.3 | | | | | | | | | | 350 | 350 |
| 100.0% | 10 | 10 | 6 | 7.6 | 9.0 | 8.3 | 8.2 | 8.3 | 8.3 | 122 | | 221 | | 19.8 | 19.4 | 20.1 | 0/0 | --- | | |
| 100.0% | 10 | 10 | 7 | 7.6 | 9.0 | 8.3 | 8.2 | 8.3 | 8.3 | | | | | | | | | | 440 | 450 |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

Remarks: Total Chlorine Residual: 0 mg/l (HACH DPD Method)

[a] Number in parentheses used in calculations since one organism was stuck to side of glass.

[b] Dead organism not found.

Table 4 . Data recorded during 48 hour, Heterandria formosa, static acute toxicity bioassay of Adcom Wire Products Cooling Water Discharge, Outfall #003, NPDES #FL0030121, Jacksonville, Florida, on 11 to 13 May, 1980.

| Conc. or % | Number of Live Organisms | | | Dissolved Oxygen (mg/ℓ) | | | pH | | | Total Alkalinity (mg/ℓ as $CaCO_3$) | | Total Hardness (mg/ℓ as $CaCO_3$) | | Temperature (°C) | | | $NH_3/NH_3+NH_4$ (mg/ℓ) | | Conductivity (μmhos) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 | 0 | 24 | 48 | 0 | 48 | 0 | 48 |
| Control | 5 | 5 | 5 | 8.0 | 8.9 | 8.4 | 7.9 | 8.2 | 8.2 | 118 | | 110 | | 20.7 | 19.6 | 20.1 | 0/0 | --- | | |
| Control | 5 | 5 | 5 | 8.0 | 8.9 | 8.4 | 7.9 | 8.2 | 8.2 | | | | | | | | | | 220 | 220 |
| 10.0% | 5 | 5 | 5 | 8.0 | 8.9 | 8.4 | 7.9 | 8.1 | 8.2 | | | | | 20.8 | 19.6 | 20.2 | | | | |
| 10.0% | 5 | 5 | 5 | 8.0 | 8.9 | 8.4 | 7.9 | 8.1 | 8.2 | | | | | | | | | | 245 | 245 |
| 18.0% | 5 | 5 | 5 | 8.1 | 8.8 | 8.4 | 7.9 | 8.1 | 8.2 | | | | | 20.8 | 19.6 | 20.2 | | | | |
| 18.0% | 5 | 5 | 5 | 8.0 | 8.8 | 8.3 | 7.9 | 8.1 | 8.2 | | | | | | | | | | 265 | 265 |
| 32.0% | 5 | 5 | 5 | 8.0 | 8.7 | 8.4 | 8.0 | 8.1 | 8.2 | | | | | 20.6 | 19.6 | 20.3 | | | | |
| 32.0% | 5 | 5 | 5 | 8.0 | 8.7 | 8.3 | 8.0 | 8.1 | 8.2 | | | | | | | | | | 300 | 300 |
| 56.0% | 5 | 5 | 5 | 8.0 | 8.7 | 8.3 | 8.0 | 8.2 | 8.2 | | | | | 20.3 | 19.6 | 20.4 | | | | |
| 56.0% | 5 | 5 | 5 | 7.9 | 8.7 | 8.3 | 8.0 | 8.2 | 8.2 | | | | | | | | | | 355 | 360 |
| 100.0% | 5 | 5 | 5 | 7.8 | 8.6 | 8.2 | 8.2 | 8.2 | 8.2 | 122 | | 221 | | 19.9 | 19.6 | 20.4 | 0/0 | --- | | |
| 100.0% | 5 | 5 | 5 | 7.8 | 8.6 | 8.2 | 8.2 | 8.2 | 8.2 | | | | | | | | | | 450 | 450 |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

Remarks: Total Chlorine Residual: 0 mg/l (HACH DPD Method)
Weight of fish: 0.0054 g each, average of 10 fish.

Table 5. $LC_{50}$ Data for Bioassay of Adcom Wire Products, Cooling Water Discharge, on 11 to 13 May, 1982.

| Organism | Method of Data Analysis | 24 $LC_{50}$ and 95% Confidence Intervals | 48 Hour $LC_{50}$ and 95% Confidence Intervals |
|---|---|---|---|
| Daphnia pulex | Binomial | a | 100.0% (10 and ∞), b |
| | Moving Average | a | 100.0% (75 and ∞),b |
| | Probit | >>100%, b | 156.4% (64 and ∞),b |
| Simocephalus serrulatus | Binomial | a | a |
| | Moving Average | a | a |
| | Probit | a | 225.9% (105 and 4122),b |
| Heterandria formosa | Binomial<br>Moving Average<br>Probit | No Mortality | No Mortality |

[a] Due to an insufficient number of dead organisms, or to the irregular distribution of mortality, an $LC_{50}$ value cannot be calculated using this method of statistical analysis.

[b] Due to the distribution of mortality, the $LC_{50}$ value calculated by this method of statistical analysis does not meet the criteria established by the Committee on Methods for Toxicity Tests with Aquatic Organisms.

## RESULTS AND DISCUSSION

The sample of Cooling Water Discharge (Outfall #003) from Adcom Wire Products was acutely toxic to Daphnia pulex (48 hour $LC_{50}$=100.0%, Table 5) and to Simocephalus serrulatus (48 hour $LC_{50}$=225.9%, Table 5), but was not toxic to Heterandria formosa. Since there is no provision for a mixing zone in Adcom's NPDES permit (Mr. Fred Birnie, personal communication), the $LC_{50}$ values determined above are in violation of the acute toxicity standards in Chapter 17-3 of the F.A.C. (see below for further discussion).

The DER Chemistry Section has analyzed a sample of this effluent for certain metals (Table 6). Several heavy metals were determined to be present, including cadmium (4.3 µg/1), copper (40 µg/1), lead (16 µg/1) and zinc (450 µg/1). Concentrations of zinc significantly less than 450 µg/1 have been shown to be acutely toxic to certain freshwater fish and invertebrates under specific test conditions (U.S. EPA 1976). Therefore, the toxicity of this effluent may well have been due to the presence of zinc and to the synergistic effects of the other metals present in the effluent.

## DISCUSSION OF THE TOXICITY CRITERIA

The toxicity standards of Chapters 17-3 and 17-4, F.A.C., are complex. Because of this complexity, they will be briefly reviewed here so that these test results may be more readily compared with the standards. For legal purposes, however, the language of the Florida Administrative Code should be consulted directly.

The two basic concepts utilized in the standards are acute and chronic toxicity, (defined in 17-3.021(1) and (3), respectively). Simplifying the actual F.A.C. language somewhat, acute toxicity is defined as the presence of a substance in a concentration one-third as great as that concentration which kills one-half of the test organisms in 96 hours, i.e., one-third of the 96 hour $LC_{50}$. Chronic toxicity is similarly defined as one-twentieth of the 96 hour $LC_{50}$. Therefore, if a test solution kills one-half or more of a group of test organisms in 96 hours, it must contain at least three times the defined "acutely toxic" concentration and at least twenty times the "chronically toxic" concentration of some sustance or substances. If a test solution causes that same mortality in less than 96 hours, (for example, in 24 or 48 hours), it is at least as toxic as the example given above, and actually is probably considerably more toxic.

The particular restrictions applied to a given discharger depend upon the existence of a mixing zone, whether as a specific part of the permit or based on the existence of a currently valid permit predating the language in Chapter 17-4 requiring mixing zone designation. In the absence of a mixing zone, the general criteria for surface waters (17-3.061) are applicable at all points, beginning at the point of discharge. This section prohibits the discharge of substances in concentrations which are chronically toxic (17-3.061(2)(o)); that is the concentrations cannot exceed one-twentieth of the 96 hour $LC_{50}$ as discussed above. If a mixing zone does exist, then this chronic toxicity standard is only applicable from the edge of the mixing zone and beyond. Within the mixing zone, the less stringent acute toxicity standard of the minimum criteria for all waters (17-3.051(1)(d)) applies: one-third of the 96 hour $LC_{50}$. The acute toxicity standard does not apply, however, to each point within a mixing zone, but rather to the average of a number of points within a mixing zone, based on the provisions of the surface water mixing zones section of Chapter 17-4 (17-4.244(4)). At the same time, though, this same rule prohibits waste concentrations within the mixing zone (i.e., at any point within the mixing zone), from exceeding the 96 hour $LC_{50}$. Therefore, at any point within a mixing zone, including the point of discharge, one-half of the test organisms cannot be killed in 96 hours.

From the above discussion, it should be clear that if the least stringent toxicity standard, the 96 hour $LC_{50}$, is exceeded at any point, from the point of discharge outwards, by any discharger, then a violation of the standards has occurred. This is an important consideration since the test procedure here reported involves the measurement of the 50% lethal concentration, and not some fraction of that concentration. Any discharger required to meet the one-twentieth of the 96 hour $LC_{50}$ standard is therefore being tested very leniently. Any reduction in the test period from 96 hours provides an added degree of leniency to a discharger.

A number of different dilutions were examined in order to determine by how much, if any, the discharge exceeds the 96 hour $LC_{50}$ standard. For example, if the sample, after two-fold dilution with diluent (a 33% concentration), kills one-half of the test organisms after 96 hours, then the sample is three times as toxic as is allowed by that standard. Similarly, if a 5% solution of the sample kills 50% of the organisms, the sample is twenty times as toxic as is allowed. Toxicities are reported here in that manner, i.e., in terms of the percentage dilution of the test sample. The smaller the percentage which is reported means a correspondingly greater toxicity.

Note that even if a discharger receives a very large mixing zone, the regulations require that the maximum toxicity at any point within the mixing zone be restricted to the 96 hour $LC_{50}$. The results here reported are based on actual effluent samples, representative of the effluent concentration which enters waters of the state at the point of discharge. If it is demonstrated that, under the conditions existing at the point of discharge, effluent concentrations will be less than at the actual sampling point (if the two points are different), the reported bioassay results will reflect the reduced discharge concentration.

With respect to the species of organisms used in these tests, the language of the F.A.C. indicates that they should be "significant to the indigenous aquatic community". All species used in these tests are significant to the indigenous aquatic community since they are sensitive to toxic substances which may be expected to impact the indigenous community.

The toxicity reported here is in excess of allowable limits.

Table 6. Results of Metal Analyses Performed on Adcom's Cooling Water Discharge (Outfall #003), collected May 10, 1982

| Metal | Concentration |
|---|---|
| Antimony | N.D. |
| Arsenic | <20 µg/l[a] |
| Beryllium | <10 µg/l[a] |
| Cadmium | 4.3 µg/l |
| Chromium | N.D. |
| Copper | 40 µg/l |
| Lead | 16 µg/l |
| Mercury | N.D. |
| Nickel | N.D. |
| Selenium | N.D. |
| Silver | N.D. |
| Thallium | N.D. |
| Zinc | 450 µg/l |

N.D. = None Detected

[a] Actual value is known to be less than value given.

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